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SPACE-TIME BEHAVIOR OF SOIL WATER STATUS
MEASURED ACROSS TWO LAND USE SYSTEMS

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Spatial variability of soil water status and its change in time are of primary importance to hydrological modeling and agricultural management. Changes in atmospheric conditions such as precipitation usually cause large temporal dynamics in soil water status; whereas, inherent soil properties such as soil texture and topography maintain their spatial pattern with time. The objective of this study was to analyze the temporal dynamics and stability of spatial field soil water status distribution and to identify the relevant underlying spatial and temporal processes. Along a 48- by 3-m transect evenly across two land use systems, cropland and grassland, soil matric potentials (ψ_m) at depths of 10, 30, 50, 70, 90 and 110 cm were measured at 1-m spatial intervals on a weekly basis from May to October, 2013. The standard deviation (STD) and spatial correlation length of ψ_m at 10 cm depth decreased with weekly precipitation and the spatial mean of ψ_m, owing to the enhancement of lateral water redistribution by elevated soil wetness. Temporal dynamics in both STD and covariance structure diminished with soil depth. Nevertheless, STD was found to positively correlate with mean ψ_m at 110 cm, which was caused by preferential flow events developed sporadically along the transect during heavy precipitation. In contrast, ψ_m's temporal stability generally increased with soil depth because of the decreased impact exerted by atmospheric conditions. According to Spearman's rank correlation coefficients, the stable spatial distribution of ψ_m was more strongly correlated with relative elevation, than with soil texture. The significant negative rank correlations and reversed spatial patterns manifested between some spatial series with distinct ψ_m at either 10 or 30 cm depth suggested that the magnitude of ψ_m needs to be taken into account when characterizing its temporal stability.

NOTES

“WETNESS” IN LANDSAT SCENES VERSUS “WETNESS” ON THE GROUND: USES OF THE TASSELLED CAP TRANSFORMATION ON ARCHIVAL IMAGERY

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“Wetness”, “greenness” and “brightness” bands or channels resulting from applying the Kauth and Thomas’ tasseled cap transformation (TCT) provide an opportunity to analyze temporal changes in these values over time, by exploring the now freely available massive Landsat scene archives (Huang et al., 2002; Baig et al., 2014).

Over time, the TC-transformed thematic mapper (TM) and enhanced thematic mapper (TM+) sensor data acquired by Landsat 5, 7 and 8 satellites produced values of wetness consistent with known locations of wetlands and water bodies. Fluctuation of “wet feature” morphology, as driven by climactic and weather patterns largely influenced the value and weight of calendar year-to-year comparisons.

References

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DYNAMICS OF SOIL QUALITY INDICATORS IN WESTERN KENTUCKY

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Evaluating soil quality is valuable in attempting to identify an ideal sustainable land management approach. Measurements of soil quality indicators have the potential to reflect the status of soil as an essential resource. The objectives of this study were to determine the biological, chemical, and physical soil quality indicators of various agricultural systems in Western Kentucky from 2009 to 2013. This study was conducted at 10 separate farming locations around Calloway and Warren counties. Soil quality indicators that were measured included water filled pore space, water stable aggregates, soil respiration, nitrate concentration, and bulk density. The results of this experiment show water filled pore space ranged from 61.66% to 70.15% and water stable aggregates ranged consistently from 57.70% to 62.13%. The estimated nitrate concentration ranged from 0.43 ppm to 10.85 ppm and soil respiration ranged from 44.36 to 73.64 lbs CO_2-C/acre/day. The bulk density of the sites varied from 1.13 to 1.48 g/cm^3. In conclusion, soil quality is important, but the dynamics of the indicators are not sufficient to identify optimum sustainable land management in Western Kentucky.

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SEDIMENT ORGANIC CARBON FATE AND TRANSPORT MECHANISMS IN A FLUVIAL KARST SYSTEM IN THE BLUEGRASS REGION

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Watershed sediment transport investigation and prediction tends to focus on the source to sink pathways, the transport energy mechanisms associated with those pathways, and the potential for sediment changes or fate during transit and at temporary storage zones. With these mechanisms in mind, we find that the role of karst as active conveyors of sediment and sediment organic carbon has not been thoroughly investigated so that it can be included in prediction models.

The application of sediment prediction tools for karst topography is particularly important in Kentucky due to the high karst susceptibility in over half of the state. Karst aquifers are major sources of drinking water in Kentucky and understanding sediment and contaminant transport in karst aquifers is vital to providing safe drinking water to many Kentucky citizens and for managing water resources in the state.

Given the considerable extent of karst topography in Kentucky and globally, understanding the role of karst on potentially modifying the transport of sediment organic carbon within the fluvial system is of particular interest. Carbon rich sediment eroded from the uplands is diverted from the typical surface water pathway by swallets that act to inject the subsurface conduit with both fluid and sediment during storm events. We hypothesize that the phreatic nature of karst conduits offer the potential to trap terrestrial-derived sediment organic carbon in the subterranean environment where microbial decomposers can turn over labile sediment organic carbon within the temporarily stored sediment.

In order to investigate and predict sediment source to sink pathways, we have chosen the Cane Run Watershed as an experimental test bed to investigate how phreatic karst conduits might inhibit transport, store sediments, and turn over sediment organic carbon before transporting it back to the fluvial system. We have applied several field-based and numerical methods including: extensive instrumentation of surface and subsurface sites with water and sediment monitoring devices in Cane Run Watershed and the subsurface karst conduit, use of isotope and fingerprinting sediment analysis, and modeling tools to describe transport of terrestrially derived sediment organic carbon in subsurface karst systems.

Research findings have shown that sediment generated by surface runoff is transported during hydrologic events to the subsurface karst conduit via a series of vertical shafts that coalesce to a primary subsurface conduit. Within the karst conduit, a downstream hydraulic control generated by the subsurface dam of the primary springhead decreases the sediment transport carrying capacity of the fluid during storm events resulting in net sediment deposition. During baseflow conditions in the conduit, i.e. no surface water flow, there is a net erosion of the conduit bed sediments due to the constant fluid shear stress and no influx of surface sediments to saturate the flow.

Over time, the deposited sediment, which is rich in organic material, is decomposed due to heterotrophic bacteria resulting in a net carbon loss of the temporarily deposited fluvial sediment that is later resuspended and recharged back to the surface water stream through estavelles and springs. We estimate a net depletion of 36% of the sediment organic carbon content due to the conduit pathway. This result is in stark contrast to purely surface water streams in the Bluegrass Region for which research has shown that organic carbon can undergo a 50% enrichment from the time it enters the stream until the time it exits.